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INTERNATIONAL BULLETIN OF BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

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Volume I July 15, 1951 Number 3

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R. E. Buchanan, R. S. Breed, S. T. Cowan

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BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

Volume I July 15, 1951 Number 3

TRANSLITERATION OF GREEK TO LATIN IN THE FORMATION OF NAMES OF BACTERIAL TAXONOMIC GROUPS (TAXA)

Proposal of a Recommendation for the Emendation of the International Bacteriological Code of Nomenclature

Many of the names of genera and of the higher taxa of plants and animals are derived from Greek words, as are also a somewhat smaller proportion of the specific epithets. In all cases these Greek words have been transliterated into Latin and treated as Latin words. Transliteration under well established rules was widely practiced by the Latins themselves. Since the classical period it has generally been customary to make use of these old Latin rules. This custom was emphasized by Linnaeus (1) in his Critica Botanica, paragraph 247 (Hort's (2) translation) in the statement:- "When Greek names are transliterated into Latin, the equivalents used by the Romans from all time must be adopted in representing the Greek letters."

However, an examination of the names and epithets derived from the Greek and used in biology reveals that there exists a degree of variation in transliteration that has led to some confusion. The non-conformities found in the literature of biology may in general be attributed to three principal causes:-

1. In a few cases the Latins used two alternative transliterations. For example, Greek words having the neuter ending -ον were generally placed in the second Latin declension with the Latin neuter ending *-um*. However, occasionally the ending *-on* was used.

2. There may be confusion between transliteration into Latin and into the alphabets of other languages. The Greek κ always became c in Latin, but when transliterated into German and frequently into English it is rendered as *k*. Similarly the Greek φ became *ph* in Latin, but in modern Italian it becomes *f*. One finds, for example, specific epithets such as *lysodeikticus* instead of *lysodicticus* and *imetrofa* for *imetropha*.

3. The number of letters in the alphabet is not the same in the Greek and in the Latin. Greek has letters not found in Latin, such as the double consonants φ, Θ, Υ, and Χ. There are more letters to represent vowels and more diphthongs in Greek than in Latin. There are other differences which make adherence to certain principles of transliteration advisable if confusion is to be avoided.

The Judicial Commission has been asked to prepare an outline which might be the basis for the formulation of a table or set of preferred forms for Greek-Latin transliteration in bacteriology (microbiology) and which might, when put into final form, be included as an appendix to the International Code of Bacteriological Nomenclature, to be listed as a recommendation.

It is urged that all interested should study the proposed tabulation and send suggestions to the Chairman of the Editorial Board. All suggestions for emendation and revision will be submitted to the Judicial Commission.

The following statement has been prepared by the Editorial Board for consideration by the Judicial Commission and by the International Committee on Bacteriological Nomenclature. In the form finally approved by the Commission it will be submitted to the Committee for final action.

An attempt has been made to draw illustrations as far as possible from the field of microbiology. The accompanying table has been drawn up after a study of several proposed formulae, including those of Linnaeus (1), Linnaeus (3), the zoological code as given by Schenk and McMasters (1948)(4) and the discussions by Clements (5). Various Latin and Greek grammars have been freely consulted, particularly those of Lane (1903)(6) and of Goodwin and Gulick (1930) (7).

BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

TRANSLITERATION OF GREEK TO LATIN IN BACTERIOLOGY

ALPHABETS Greek	ALPHABETS Latin	COMBINATIONS Greek	COMBINATIONS Latin	TRANSLITERATION From Greek	TRANSLITERATION To Latin	EXAMPLES FROM MICROBIOLOGY
Α α	A a	-	-	ἀκτίς	*actis*	*Actinomyces*
-	-	-	-	ἀκτῖνος	*actinis*	-
-	-	αι	ae	αἷμα	*haema*	*Haemophilus*
-	-	αυ	au	αὔξω	*auxō*	*auxinophilus*
-	-	ἁ	ha	ἅλς	*hals*	*halophilus*
-	-	-	-	ἁλός	*halis*	-
Β β	B b	-	-	βακτήριον	*bactērium*	*Bacterium*
Γ γ	G g	-	-	γαλα	*gala*	*Galactococcus*
-	-	-	-	γάλακτος	*galactis*	-
-	-	γγ	ng	ἄγγος	*angus*	*Synangium*
-	-	γκ	nc	ἐγκέφαλος	*encephalus*	*encephaloides*
-	-	γξ	nx	σφίγξ	*sphinx*	*Sphinx*
-	-	γχ	nch	σύγχυσις	*synchysis*	*synchyseus*
Δ δ	D d	-	-	διπλοῦς	*diplus*	*Diplococcus*
Ε ε	E e	-	-	ἔντερον	*enterum*	*Enterococcus*
-	-	ει	i	θεῖον	*thium*	*Thioploca*
-	-	ει	e	ζειά	*zea*	*zeae*
-	-	ευ	eu	εὐρύς	*eurys*	*eurystreptus*
-	-	ἑ	he	ἕλκος	*helcus*	*helcogenes*
Ζ ζ	Z z	-	-	ζῷον	*zōum*	*Azotobacter*

TRANSLITERATION OF GREEK TO LATIN IN BACTERIOLOGY (Continued)

ALPHABETS Greek	Latin	COMBINATIONS Greek	Latin	TRANSLITERATION From Greek	to Latin	EXAMPLES FROM MICROBIOLOGY
Η η	E e	-	-	οἴδημα	*oedēma*	*oedematiens*
-	-	ἡ	he	ἥλιος	*hēlius*	*helianthi*
-	-	η final	e	χαιτη	*chaetē*	*Spirochaete*
-	-	η final	a	-	*chaeta*	*Spirochaeta*
Θ θ	Th th	-	-	θρίξ	*thrix*	*Erysipelothrix*
Ι ι	I i	-	-	ἰχθύς	*ichthys*	*ichthyosmius*
-	-	ἰ	hi	ἵππος	*hippus*	*hippopotami*
Κ κ	C c	-	-	κορύνη	*corynē*	*Corynebacterium*
Λ λ	L l	-	-	λευκός	*leucus*	*Leuconostoc*
Μ μ	M m	-	-	μικρός	*micrus*	*Micrococcus*
Ν ν	N n	-	-	νεκρός	*necrus*	*necrophorus*
Ξ ξ	X x	-	-	μύξα	*myxa*	*Myxobacter*
Ο ο	O o	-	-	ὄζαινα	*ozaena*	*ozaenae*
-	-	οι	oe	οἴδημα	*oedēma*	*oedematiens*
-	-	ον final	um	ἀγγεῖον	*angium*	*Archangium*
-	-	όν final	on	περσικόν	*persicon*	*Lycopersicon*
-	-	ος final	us	φῖλος	*philus*	*hydrophilus*
-	-	ος final	os	-	-	-
-	-	ος genitive	is	ἐρυσίπελατος	*erysipelatis*	*erysipelatis*
-	-	ος genitive	os	ὗς	*hys, hyos*	*hyos*

BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

TRANSLITERATION OF GREEK TO LATIN IN BACTERIOLOGY (Continued)

ALPHABETS Greek	Latin	COMBINATIONS Greek	Latin	TRANSLITERATION From Greek	to Latin	EXAMPLES FROM MICROBIOLOGY
-	-	ου	u	πούς	*pus*	*Rhizopus*
-	-	ὁ	ho	ὅρμος	*hormus*	*Hormiscium*
Π π	P p	-	-	πλάνος	*planus*	*Mycoplana*
Ρ ρ	R r	-	-	σπεῖρα	*spira*	*Spirochaeta*
-	-	ῥ initial	rh	ῥόδον	*rhodum*	*Rhodobacteriaceae*
-	-	ρρ	rrh	διάρροια	*diarrhoea*	*diarrhoeae*
Σ σ ς	S s	σ	s	σπεῖρα	*spira*	*Spirochaeta*
-	-	ς	s	κυάνεος	*cyaneus*	*pyocyaneus*
Τ τ	T t	-	-	τέτρα	*tetra*	*tetragena*
Υ υ	Y y	-	-	μυκης	*mycēs*	*Schizomycetes*
-	-	αυ	au	αὔξη	*auxē*	*auxinophilum*
-	-	ευ	eu	ευ	*eu*	*Eubacteriales*
-	-	ου	u	πούς	*pus*	*Rhizopus*
-	-	ὑ	hy	ὑδρο	*hydro*	*Hydrogenomonas*
Φ φ	Ph ph	-	-	φαγός	*phagus*	*Phagus*
Χ χ	Ch ch	-	-	χλαμύς	*chamys-*	*chlamys bacteriales*
-	-	-	-	χλαμύδος	*chlamydis*	-
Ψ ψ	Ps ps	-	-	ψευδής	*pseudēs*	*Pseudomonas*
Ω ω	O o	-	-	ᾠόν	*ōum*	*Oöspora*
-	-	ὡ	hō	ὥρα	*hōra*	-

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BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

THE LEGITIMACY OF CERTAIN GENERIC HOMONYMS IN BACTERIOLOGY AND PROTOZOOLOGY

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A report (1) in the form of a mimeographed list of generic and subgeneric names proposed for protozoa up to the year 1939 (approximately) was submitted and distributed at the meeting of the Third Microbiological Congress in New York in 1939. About 6800 names were included, together with the names of homonyms found in other animal groups. Some additional copies of this list were later distributed to workers upon request. There was also presented at this Congress a brief list of names which had been proposed for genera both in bacteriology and protozoology, with some comments upon usage, priority and legitimacy. For some reason this paper was not included in the printed Proceedings of the Third Congress. It has been believed desirable to revise this older manuscript and to add to it discussions of some additional names. The present paper is an attempt to determine the legitimacy of names of genera and subgenera that are based upon different types and that have been proposed both in bacteriology and in protozoology.

Rule 24 of the International Bacteriological Code of Nomenclature states in part:- "A name of a taxonomic group is illegitimate in the following cases:-
(4). If it is a later homonym of a genus of bacteria, of a genus of plants, or of a genus of protozoa; that is, if it duplicates a name previously and validly published for a group of the same rank based on a different type. Even if the earlier homonym is illegitimate or if generally treated as a synonym on taxonomic grounds, the later homonym must be rejected."

It may be noted that there is no corresponding provision in the zoological code which would suppress generic names of protozoa that are later homonyms of generic names in bacteriology. Apparently both homonyms are legitimate if that proposed in bacteriology antedates that given in protozoology. The author suggests that this anomalous situation be called to the attention of the Zoological Commission in the hope that provision be made for a reciprocal arrangement which would clarify the situation in microbiology.

Fourteen generic and subgeneric

names, based on different type species, have been introduced independently in the literature of both bacteriology and protozoology. The legitimacy of the following should be considered: *Astasia, Babesia, Castellanella, Charon, Coccomonas, Klebsiella, Listerella, Palmula, Pelosphaera, Pfeifferella, Phytomonas, Proteus, Rhizomonas, Rhodosphaera.*

1. *Astasia*

Astasia Ehrenberg 1830 (2, p. 38).
Type species. *Astasia euchlora* Ehrenberg 1830.
This protozoan generic name has been commonly recognized by protozoologists. It is placed in the *Mastigophora, Phytomastigina.* According to Schulze and Kuekenthal (3), *Astasia* was also proposed by Scudder (1869) as the name for a genus of *Lepidoptera,* and is probably to be regarded as a later illegitimate homonym.

Astasia Meyer 1897 (4, p. 185).
Type species. *Astasia asterospora* Meyer 1897.
This genus of endospore-bearing rods was segregated from the bacterial genus *Bacillus.* It was made a subgenus of *Bacillus* by Buchanan 1918 (5, p. 38).

Astasia Pribram 1929 (6, p. 374).
Type species. No species listed.
The genus *Astasia* Pribram is evidently segregated from the bacterial genus *Bacillus,* but there is no evidence that it is based on the same type as *Astasia* Meyer.

Conclusion. *Astasia* Meyer 1897 and *Astasia* Pribram 1929 proposed as genera of bacteria are later homonyms of the protozoan genus *Astasia* Ehrenberg and illegitimate in bacteriology.

2. *Babesia*

Babesia Trevisan 1889 (7, p. 29).
Type species. *Babesia xanthopyrethica* Trevisan 1889.
This name was applied by Trevisan to the organism which Babes in 1883 believed to be the causal organism of yellow fever in man. Inasmuch as this species is apparently not identifiable, possibly the second species named by Trevisan should be regarded as the type species. This is the *Babesia erysipeloidis* Trevisan 1889, the "Coccus della erisipeloide o erisipela cronica Rosenbach 1887." This is apparently the organism called *Erysipelothrix erysipeloidis* (Lehmann and Neumann) Rosenbach in the Bergey Manual (Ed. 6, 1948), which should probably be corrected to *Erysipelothrix erysipeloidis* (Trevisan) Rosenbach. Whether *Babesia* Trevisan 1889 makes *Erysipelothrix* Rosenbach 1909 a later synonym is a problem that may well be considered by the Judicial Commission of the International Committee on Bacteriological Nomenclature. Ac-

cording to Nannizzi (Bergey's Manual Ed. 6, 1948) the name *Babesia erysipeloides* was used by Chalmers and Christopherson (8), but an examination of the original fails to confirm this statement. *Babesia* has not been commonly used as a generic name in bacteriology.

Babesia Starcovici 1893 (9,p.1)
Type species. *Babesia bovis* (Babes) Stareovici 1893. *Babesia* is the commonly accepted name of a genus of protozoan blood parasites. It is a later homonym of *Babesia* Trevisan, but this would not make it illegitimate under the rules of the zoological code.

Conclusion. Consideration should be given to the legitimacy of the generic name *Babesia* Trevisan 1889 in bacteriology. If found to be legitimate, consideration should also be given to its possible suppression inasmuch as confusion is inevitable in microbiology if two generic names *(Babesia)* are used, one for protozoan blood parasites of animals, and one for bacterial parasites of man and animals.

3. *Castellanella*

Castellanella Chalmers 1918 (10, p. 223).
Type species. *Castellanella gambiense* (Dutton) Chalmers 1918 = *Trypanosoma gambiensis* Dutton 1902.

Chalmers segregated *Castellanella* from *Trypanosoma* as a genus of blood protozoa. Although this generic name is not commonly used, it seems to have been validly published and is legitimate.

Castellanella Pacheco and Rodrigues 1930 (11, p. 166).
Type species. *Castellanella alcalescens* (Andrewes) Pacheco and Rodrigues 1930 = *Bacillus alkalescens* Andrewes 1918.
The type species of this genus is included in the family *Enterobacteriaceae* as *Shigella alkalescens* (Andrewes) Weldin 1927. The genus *Castellanella* Pacheco and Rodrigues seems to have been validly published.

Conclusion. The genus *Castellanella* Pacheco and Rodrigues is probably to be regarded as illegitimate, being a later homonym of *Castellanella* Chalmers.

4. *Charon*

Charon Karsch 1879 (12, p. 197).
Type species. *Charon grayi* (Gervais) Karsch 1879. This was apparently validly published as a genus in the *Arachnida*. Its significance in microbiology stems from the fact that it is an earlier homonym of *Charon* Jameson 1925 next to be noted.

Charon Jameson 1925 (13, p. 403).
Type species. *Charon ventriculi* Jameson 1925.
The protozoan genus *Charon* Jameson seems to have been validly

published, but is probably to be regarded as an illegitimate later homonym of *Charon* Karsch.

Charon Holmes 1948. (14, p. 1265).
Type species. *Charon evagatus* Holmes 1948.
This generic name was validly published by Holmes for a genus of the family *Charonaceae* included in the filterable animal viruses. It is a later homonym both of *Charon* Karsch and *Charon* Jameson.

Conclusion. *Charon* Holmes 1948 may be regarded as an illegitimate later homonym of the name of the protozoan genus *Charon* Jameson 1925.

5. *Coccomonas*

Coccomonas Stein 1878 (15, Plate XXIV).
Type species. *Coccomonas orbicularis* Stein 1878.
Illustrated as a genus and species of protozoa.

Coccomonas Orla-Jensen 1921 (16, p. 268).
Type species. None listed. In a general discussion of his "Natural Bacterial System" the author makes a tentative proposal. "For the Gram-negative, non-acid-forming or, at most, very slightly acid-forming cocci (among which must probably be reckoned the gonococci and the meningococci too, as well as the Gram-negative streptococci, if such exist) we might simply use the generic name *Coccus*, or, if they should turn out to have terminal flagella, *Coccomonas*."

Conclusion. *Coccomonas* Orla-Jensen is a later homonym of *Coccomonas* Stein. It probably should be regarded as not validly published, and having no standing in bacteriological nomenclature.

6. *Klebsiella*

Klebsiella Trevisan 1885 (17, p. 105).
Type species. *Klebsiella pneumoniae* (Schroeter) Trevisan 1887. Trevisan described this bacterial genus in 1885 with a single species *Klebsiella crouposa*, the *Bacterium pneumoniae-crouposae* Zopf 1885. Later (1887) he designated this organism as *Klebsiella pneumoniae* and still later (1889) as *Klebsiella friedlanderi*.
Klebsiella is a commonly accepted genus in bacteriology.

Klebsiella Meunier 1908 (18, p. 245).
Type species. *Klebsiella exstincta* Meunier 1908.
This was described as a genus of fossil insects, apparently of the family of *Protoblattidae*.

Klebsiella Pascher 1931 (19, p. 322).
Type species. *Klebsiella alligata* Pascher 1931.
A new protozoan genus and species assigned to *Mastigophora*, *Phytomastigina*.

Conclusion. *Klebsiella* Trevisan may be regarded as a validly published and legitimate generic name in the bacteria. *Klebsiella* Pascher 1931 is a later homonym of *Klebsiella* Meunier 1908.

7. *Listerella*

Listerella Jahn 1906 (10, p. 540).
Type species. *Listerella paradoxa* Jahn 1906.
This new genus and species were included in the *Myxomycetes* or slime molds *(Mycetozoa)*.

Listerella Pirie 1927 (21, p. 164).
Type species. *Listerella monocytogenes* (Murray, Webb and Swann) Pirie = *Listerella hepatolytica* Pirie 1927 = *Bacterium monocytogenes* Murray, Webb and Swann 1926.
Described as a new genus of bacteria.

Listerella Cushman 1933 (22, p. 36).
Type species. *Listerella primaeva* Cushman 1933.
A genus and species of protozoa assigned to the *Foraminifera*.

Conclusion. The generic name *Listerella* Pirie in bacteriology is an illegitimate later homonym of *Listerella* Jahn 1906. Inasmuch as the slime molds are usually included by the zoologists among the protozoa, it would seem that *Listerella* Cushman should also be regarded as a later and illegitimate homonym of *Listerella* Jahn. Pirie (23) in 1940 recognized the priority of *Listerella* Jahn and proposed *Listeria* to replace it. The latter name seems not to have been used in protozoology, but *Listeria* has twice been proposed as a generic name in the flowering plants. The bacteriological status of *Listeria* therefore requires study from the standpoint of botanical priority.

8. *Palmula*

Palmula Lea 1833 (24, p. 219).
Type species. *Palmula sagittaria* Lea 1833.
The standing of this generic name in the *Foraminifera (Protozoa)* has been somewhat problematical. Galloway (25, p. 240) and Cushman (26, p. 182) both regarded *Palmula* Lea 1833 as a synonym of *Flabellina* d'Orbigny 1839. However, Cushman (27) recognizes *Palmula* Lea and reduces *Flabellina* d'Orbigny to synonymy.

Palmula Prévot 1938 (28, p. 88).
Type species. *Palmula spermoides* (Ninni) Prévot.
Prévot placed this genus with the anaerobic sporebearing bacteria.

Conclusion. *Palmula* Prévot 1938 is probably to be regarded as a later homonym of *Palmula* Lea 1833. Prévot (29) later proposed the generic name *Acuformis* Prévot (29, p. 164) to replace *Palmula* Prévot 1938.

9. *Pelosphaera*

Pelosphaera Lauterborn 1906 30, p. 197).
Type species. *Pelosphaera rotans* Lauterborn 1906.
Described as belonging to the bacteria. In current use.

Pelosphaera Heron-Allen and Earland 1932 (31, p. 255).
Type species. *Pelosphaera cornuta* Heron-Allen and Earland 1932.
Described as a protozoan genus in the *Foraminifera*. The generic name is in current use.

Conclusion. The generic name *Pelosphaera* Lauterborn 1906 was validly published, and is probably legitimate. The protozoan name *Pelosphaera* Heron-Allen and Earland 1932 is probably also valid and legitimate under the rules.

10. *Pfeifferella*

Pfeifferella Labbé 1899 (32, p. 60).
Type species. *Pfeifferella tritonis* Labbé = *Pfeifferia tritonis* Labbé 1894, not *Pfeifferia* Gray 1853.
A genus placed by the author in the *Sporozoa*.

Pfeifferella Buchanan 1918 (5, p. 54).
Type species. *Pfeifferella mallei* (Loeffler) Buchanan.
The type species is the glanders bacillus, one of the bacteria.

Conclusion. *Pfeifferella* Buchanan 1918 is an illegitimate later homonym of *Pfeifferella* Labbé 1899.

11. *Phytomonas*

Phytomonas Donovan 1909 (33, p. 1496).
Type species. *Phytomonas davidi* (Lafont) Donovan 1909 = *Leptomonas davidi* Lafont.
The standing of *Phytomonas* as a protozoan genus is somewhat compromised by the fact that Donovan gave no description of the genus, and did not name a species. However, his reference to the work of Lafont (34) has apparently led to the acceptance of the name in protozoology.

Phytomonas Bergey, Harrison, Breed, Hammer and Huntoon 1923 (35, p. 174).
Type species. *Phytomonas campestris* (Pammel) Bergey *et al.* 1923 = *Bacillus campestris* Pammel 1895. Elliott (36) pointed out in 1937 that *Phytomonas* Bergey *et al.* is a later homonym of *Phytomonas* Donovan 1909. Dowson (37) proposed the generic name *Xanthomonas* to replace *Phytomonas* Bergey *et al.* but failed to retain the type species of the latter. He incorrectly designated the type species as *Xanthomonas hyacinthi* (Wakker) Dowson. Probably it should be *Xanthomonas campestris* (Pammel) Dowson.

Conclusion. *Phytomonas* Bergey *et al.* is an illegitimate later homonym of *Phytomonas* Donovan 1909.

12. *Proteus*

Proteus Laurenti 1768 (38, p. 35).
Type species. *Proteus anguinus* Laurenti 1768.
The species described is placed in the *Amphibia*. The name is apparently currently accepted and used, as by Noble 1931 (39, p. 483).

Proteus Mueller 1786 (40, p. 91).
Type species. *Proteus diffluens* Mueller 1786.
This protozoan generic name was apparently a later homonym of *Proteus* Laurenti 1768.

Proteus Hauser 1885 (41, p. 1).
Type species. *Proteus vulgaris* Hauser 1885.
The generic name *Proteus* Hauser 1885 for a genus of bacteria is apparently a later homonym of the generic name *Proteus* Mueller 1786. It is therefore illegitimate.

Conclusion. Apparently the generic name *Proteus* Mueller 1786 is itself illegitimate as a later homonym of *Proteus* Laurenti 1768 under the Zoological Code. The generic name *Proteus* Hauser is widely used in bacteriology. It may be desirable to request that *Proteus* Hauser be made a *genus conservandum* in bacteriology, inasmuch as *Proteus* is not currently used as a generic name in protozoology.

13. *Rhizomonas*

Rhizomonas Kent 1880 (42, p. 224).
Type species. *Rhizomonas verrucosa* Kent 1880.
A protozoon observed in hay infusions.

Rhizomonas Orla-Jensen 1909 (43, p. 334).
Type species. None named.
Possibly *Rhizomonas radicicola*.
Proposed to replace the bacterial generic name *Rhizobium*, of which it is a later synonym.

Conclusion. *Rhizomonas* Orla-Jensen is a later homonym of *Rhizomonas* Kent. The validity of its publication may be questioned.

14. *Rhodosphaera*

Rhodosphaera Haeckel 1881 (44, p. 452).
Type species. No species listed.
The name was applied to a protozoan genus *(Radiolaria)*.

Rhodosphaera Buchanan 1918 (45, p. 472).
Type species. *Rhodosphaera capsulatus* (Molisch) Buchanan.
This bacterial genus was proposed to replace the generic name *Rhodococcus* Molisch which name is a later homonym of the bacterial generic name *Rhodococcus* Zopf.

Conclusion. *Rhodosphaera* Buchanan 1918 is a later homonym of the protozoan generic name *Rhodosphaera* Haeckel.

SUMMARY

1. The bacterial and viral generic names *Astasia* Meyer, *Castellanella* Pacheco and Rodrigues, *Charon* Holmes, *Coccomonas* Orla-Jensen, *Palmula* Prévot, *Pfeifferella* Buchanan, *Phytomonas* Bergey *et al.*, *Proteus* Hauser, *Rhizomonas* Orla-Jensen and *Rhodosphaera* Buchanan may be regarded as later homonyms of protozoan genera, and hence unavailable in bacteriology except by international agreement.

2. The bacterial generic names *Babesia* Trevisan, *Klebsiella* Trevisan, *Pelosphaera* Lauterborn are legitimate in the sense that they are earlier homonyms of the duplicating protozoan generic names.

3. The bacterial generic name *Listerella* Pirie is an illegitimate later homonym of *Listerella* Jahn.

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BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

STEMS AND COMBINING FORMS OF

OPSIS, OPS AND *ŌPS*

Preliminary Statement File No. 4

An OPINION has been requested relative to the correct spelling of the stems and combining forms of several Greek words:

ὄψις = opsis ὄψ = ops and ὠψ = ōps

Specific and subspecific epithets and names of genera, subgenera and higher taxa derived from these words are common in biology. Specific epithets which include the stems of these words are numerous in microbiology.

The request for an OPINION was initiated by students of the yeasts who asked whether the changes of the family name *Torulopsaceae* to *Torulopsidaceae* and of the subfamily name *Torulopsoideae* to *Torulopsidoideae*, all based upon the generic name *Torulopsis*, as proposed by Diddens and Lodder (1), were etymologically justified. The Judicial Commission, under Provision 5-B-10 of the International Bacteriological Code of Nomenclature, is directed:-"When requested, to prepare Opinions relative to the nomenclatural status of microorganisms studied by microbiological techniques, but not classed with the bacteria or the viruses, as, for example, the yeasts, molds, algae and protozoa. Opinions relating to organisms in these groups shall not be issued until they have been approved by the Commission or Executive Committee charged with the interpretation of the appropriate code of nomenclature (zoological or botanical)."

A brief survey revealed much confusion in bacteriology, in botany and in zoology with reference to the combining forms of these words, confusion likewise as to the declensions of derived nouns and adjectives, and difficulties arising from confusion of derivatives of these words with other words having somewhat similar spelling. Exploration of the problem seemed desirable. A preliminary statement has been prepared to give background for consideration and discussion by the Commission.

A knowledge of the stems and of the combining forms of generic names and specific epithets ending in *-opsis*, in *-ops* and in *-ōps*, or in derivatives of these or similar suffixes is desirable for several reasons:-

1. To fix the spelling of the oblique cases, particular-

ly the genitive of generic names in *-opsis*, *-ops*, or *-ōps*. Microbiologists are concerned with the problem because the specific epithets of the names of very many microorganisms are the genitives of the generic names of the hosts. It is found that there is a confusing lack of uniformity in usage.

2. To fix the spelling of the names of higher taxa derived from the names of genera in *-opsis*, *-ops* or *-ōps*, in particular the spelling of the names of families. A preliminary survey shows that there is confusion and lack of uniformity, both in botany and in zoology.

3. To fix the spelling and declension of adjectives ending in *-opsis*, *-ops* or *-ōps*, and the derivation of related adjectives.

4. To differentiate compounds derived from *opsis* and *ops* from compounds derived from other words with similar spelling.

The use of the terms "stem" and "combining form" in biology.

Some confusion exists in biological nomenclature as to the meaning and use of the word "stem" as applied to Latin and latinized nouns such as the names of genera. The phrase "combining form", perhaps more appropriate, is also used, and may require definition.

The botanical and bacteriological codes of nomenclature agree that names of certain higher taxa are Latin words or latinized words, and have definite suffixes to fix their taxonomic rank. The ending for family, for example, is *-aceae*. Family names are to be derived from the name of one of the included genera. No instructions are to be found as to modification of the generic name upon the addition of the suffix.

The zoological code is more explicit. It specifies that the suffix indicating a family name shall be added to the stem of the type genus.

The word stem as used by the zoologist is not precisely the stem of the grammarian. The latter states that the stems of Latin nouns in the first declension end in *-a*, those of the second declension in *-o*, and those of the third declension in a consonant or in *-i*. The "stem" of the zoological code is the grammarian's stem without the final vowel. This latter curtailed stem is frequently called the "combining form."

The combining form is the Latin name stem without the final stem vowel. For practical purposes it is obtained by dropping the endings shown for the

genitive in the dictionary, i.e., the *-ae* in the first declension, the *-i* in the second and the *-is* in the third.

The phrase "combining form" rather than "stem" will generally be used in this discussion.

Frequency of combining forms of *opsis*, of *ops* and of *ōps* in names or epithets used in biology.

A brief and incomplete survey showed that more than 500 names derived from *opsis*, *ops* or *ōps*, or with these endings, are generic names or specific epithets in microbiology, for the most part in the fungi.

The Greek feminine noun ὄψις, ὄψεως = *opsis*, *opseōs* usually means the look or appearance of a person or a thing. It is perhaps best translated in compounds as *aspect*.

Generic names ending in *-opsis* are common throughout biology. In botany Sprague (2) found that twelve of the first hundred generic names beginning with A in Dalla Torres and Harm's *Genera Siphonogamarum* have *-opsis* as the final component. Clements and Shear (3), in their index to the second edition of Genera of Fungi, list nearly 5000 generic names of which 193 end in *-opsis*, about 2 per cent. Smith (4) recognizes 13 such generic names among those of fresh water algae in the United States. Protozoan generic names ending in *-opsis* are not quite so abundant proportionately. Of the 6800 protozoan generic and subgeneric names listed by Becker and Kuhn (5), 73 have this ending. The ending is common in the higher zoological phyla. *Bacteriopsis* and *Bacillopsis* are bacterial generic names. Further, the specific epithets of hundreds of species of parasitic fungi, bacteria, protozoa and other forms are derived from generic names ending in *-opsis*.

The Greeks had three words transliterated into Latin as *ops*. They are:

ὄψ = *ops*, = a voice or word, a feminine poetic word used only in oblique cases in the singular. No examples of its use in biology have been found.

ὄψ, ὄπος = *ops*, *opis* = the eye or face, feminine noun.

ὦψ, ὠπος = *ōps*, *ōpis* = the eye, face, countenance, feminine noun.

The two latter words, while spelled differently in the Greek, are similarly transliterated into Latin, and for practical purposes may be considered together. The existence of a long ō in some derived words may be noted.

Botanical generic names ending in *-ops* are not common. A

brief search revealed three, *Aegilops*, *Echinops* and *Balanops*. This ending is much more common in generic names in zoology. About a dozen were found in a check of the systematic index of a recent volume of Biological Abstracts.

Nouns having *opsis* as a final component.

Most Greek stems ending in -ι = *-i* with nominatives in -ις = *-is* in the third declension form the genitive by changing the *-i* of the stem to -ε and adding -ως for the singular and -ων for the plural. The Greek lexicon (Liddell-Scott) gives nominative ὄψις, genitive singular ὄψεως and genitive plural ὄψεων. Compound Greek nouns ending in -οψις = *-opsis* are also feminine and are declined as is ὄψις. This ending gives to a compound noun the meaning of "that which resembles" or "that has the aspect of" or "new" or "aspect". Buck and Petersen (6) list 320 Greek words in -ψις = *-psis*, mostly feminine nouns with a few adjectives. Twenty-five are nouns that end in *-opsis*. Of these 14 are derived from ὄψις = *opsis*, 6 others end in -κοψις = *-copsis* and 3 in *-scopsis*. Among the Greek compound nouns from ὄψις = *opsis* are the following:

γαλιόψις, εως = *galiopsis*, εος = that which resembles galium (a plant).
δίοψις, εως = *diopsis*, εος = a view through, perspicacity.
κάτοψις, εως = *catopsis*, εος = a sight, view.
πρόοψις, εως = *proopsis*, εος = *a foreseeing*.
ἄποψις, εως = apopsis, εος = outlook, view, prospect.
εἴσοψις, εως = *isopsis*, εος = a spectacle.
ἔποψις, εως = *epopsis*, εος = a view over.
ὕπεροψις, εως = *hyperopsis*, εος = contempt, disdain.
σύνοψις, εως = *synopsis*, εος = general view, synopsis.
πρόσοψις, εως = *prosopsis*, εος = appearance, aspect, view.
An exception is to be found in:
λύκοψις, ιδος = *lycopsis, idis* = a variant spelling of *lycapsis* and not a derivative of *opsis*.

Some of the Greek nouns ending in *-opsis* were taken over by the Romans. They were placed in the third declension with genitive singular *-is* and genitive plural *-ium*. For example, the following are found in Haynes' Latin Dictionary:

γαλιόψις, εως = *galeopsis, is.*
σύνοψις, εως = *synopsis, is.*
λύκοψις, ιδος = *lycopsis, is.*
(Note that in Greek this is an imparasyllable, in Latin parasyllabic.)

The Latins placed words ending in *-opsis* with the parasyllabic nouns whose nominatives end in *-is*. The stem is *-opsi-*, the combining form *-ops-*, and the genitive singular *-opsis*. Family names derived from generic names ending in *-opsis* in bota-

ny would end in *-opsaceae* and in zoology in *-opsidae*.

However, in the modern Latin of biology, there have developed two diverse usages. Some authors follow what would appear to be classic precedent in the choice of stem and combining forms. Others place words ending in *-opsis* in the third declension with the stem ending in *d*, (like *cuspis, cuspidis*, stem *cuspid*, a spear point), the nominative singular being *-opsis*, and genitive singular and plural *-opsidis* and *-opsidum*. Search has thus far failed to reveal any Latin precedent for the latter. An examination of the literature makes it evident that there is much confusion. Some authors consider the gender of generic names ending in *-opsis* to be *-opsis*, others use *-opsidis*. Some use *-ops-* as the combining form in names of higher taxa, others use *-opsid-*. There is lack of agreement among those who write Latin diagnoses in describing plants as to the declension of these names. When the *-opsid-* as the stem of *-opsis* was first used has not been determined. Linnaeus (7) used both stems. For example, in one place (8) he says: "*altero in loco imposita Galeopsi cum Heuchero*", and in another (9), "*gerit fructificationem absolute Coreopsidis*" and "*vero Coreopsidis generis.*"

Other botanical evidence may be found in the names of hosts listed in the Latin diagnoses of fungus species. For example, in Saccardo (10) we find under *Phialea glaucescens*, "*Hab. in culeis fructum Castanopsidis*", under *Cercospora thermopsidis*, "*Hab. in foliis Thermopsidis arenariae*". deToni (11) used the phrases "*in diagnosi generis Bryopsidis*" and "*in Bryopside plumosa.*"

The diversity of usage shows up particularly in the names of microorganisms whose specific epithets are formed from the genitive of the generic name of the host.

Some have the genitive singular ending *-opsis*, such as *Laboulbenia diopsis* from the insect genus *Diopsis*, *Rickia europsis* from the insect genus *Europsis* and *Stictis chrysopsis* from the spermatophyte genus *Chrysopsis*. But a much larger number carry the genitive ending as *-opsidis*, as in *Calloria galeopsidis* and *Cyclospora ampelopsidis*. It is interesting to note that of two organisms parasitic on *Chrysopsis*, one was named *Stictis chrysopsis*, the other *Aecidium chrysopsidis*. Many specific epithets ending in *-opsis* apparently are adjectives (as noted below).

The combining form or stem also determines the spelling of the derived names of families and of higher taxa. A brief survey of plant groups revealed *Bryopsidaceae* from *Bryopsis* (an algal genus), *Mastigocladopsidaceae* from *Mastigocladopsis* (an

algal genus), *Hymenophyllopsidaceae* from *Hymenophyllopsis* (a fern genus) and *Coriopsidaceae* from *Coriopsis* (a genus of *Spermatophyta*). Diddens and Lodder (12) first proposed the family and subfamily names *Torulopsaceae* and *Torulopsoideae* derived from the name of the yeast genus *Torulopsis*. Later (13) it was concluded on the basis of botanical precedents that the names should be spelled *Torulopsidaceae* and *Torulopsidoideae*. No example of the formation of a family name from a generic name ending in *-opsis* in bacteriology has been found. However, acceptance by botanists of *-ops-* as the combining form of *opsis* may be found in such generic names as *Dacryopsella*, *Discomycopsella*, *Dothideopsella* and *Lecidiopsella*. It would seem that in botany the tendency has been to regard *-opsid-* rather than *-ops-* as the combining form.

In zoology, the situation seems to be quite reversed. In all cases noted the combining form is *-ops-*, as witness the family names, *Amblyopsidae* from *Amblyopsis*, *Percopsidae* from *Percopsis*, *Limopsidae* from *Limopsis*, *Cambalopsidae* from *Cambalopsis*, *Chaenopsidae* from *Chaenopsis*, *Solenopsidae* from *Solenopsis*, and the subfamily name *Atrypopsinae* from *Atrypopsis*. No example has been found in which any combining form other than *-ops-* has been recognized or used. No reason for the disparity between practice in botany and zoology has been found.

Adjectives having *opsis* as a final component.

Sprague (13) made a careful study of the contention that the ending *-opsis* is essentially adjectival. He was concerned primarily with generic names and concluded that the ending was that of nouns. However, he states: "No Greek adjectives have been traced" (i.e., adjectives ending in *-opsis*.) Apparently no extensive study of this point was made.

Buck and Petersen (14) list eight Greek adjectives ending in *-οψις* = *-opsis*. Among them are the following used only as masculine and feminine, never neuter.

μάκροψις = *macropsis*, long faced.
πλατύοψις = *platyopsis*, broad faced.
στρογγύλοψις = *strongylopsis*, round faced.
φάκοψις = *phacopsis*, freckle-faced.

It is stated (private correspondence, Miss Lodder) that these adjectives did not occur in the classical or Hellenistic period. It seems that in biological nomenclature many adjectival specific epithets ending in *-opsis* have been coined. The following names of species are representative of those used in microbiology:

Melanconium hysteriopsis = comb-like.
Lepiota coprinopsis = *Coprinus*-like.
Fusarium acremoniopsis = *Acremonium*-like.
Moelleroclavus penicilliopsis = *Penicillium*-like.
Hysterium gloniopsis = *Gloniu*m-like.
Heterochaete kneiffiopsis = *Kneiffia*-like.
Septoria melanopsis = dark, black-like.
Dematium chaetopsis = spine-like.

It will be noted that apparently in biological use adjectives in *-opsis* are regarded as having one ending *-is* and usable as specific epithets with generic names in the neuter, as well as masculine and feminine. No case has been noted in which the Latin endings *-is, is, e,* as in *communis, is, e* are used.

Nouns having *ops* as a final component.

The two Greek words which are significant in formation of compounds are ὄψ = *ops*, sight, and ὤψ = *ōps*, eye or face. All form the genitive in *-πος* = *-pos*. Concerning these endings Buck and Petersen (14) make the following pertinent observations. "Approach to suffixal use occurs commonly in the compounds of ὤψ, eye, face (gen. *-pos*). Thus . . . . the force of *-ωψ* is practically that of a possessive suffix and may be translated by 'having' or 'characterized by'. Even in Homeric times the form *-ωψ* shows scarcely a trace of its original meaning, but is used like many a suffix merely to denote similarity, e.g., in οἰνώψ 'wine colored' when applied to the sea, αἰθωψ 'fiery' used of bronze." "There is a considerable group of animal names. It is possible to read the notion of appurtenance into ῥώψ 'wood pecker': δρῦς oak, and of agency into σκάλωψ 'mole' (digger): σκάλλω. But in most of them the suffix has no tangible meaning. In general it is impossible to draw a sharp line between true compounds and suffixal *-οψ* and *-ωψ*."

These authors list 10 Greek compounds as derived from ὄψ = *ops*, sight, and 14 Greek nouns to which οψ is not definitely related. They also list 45 Greek compounds with *-ωψ* = *-ōps*, eye, face, as the final component, and 44 Greek nouns with *-ωψ* not directly so derived.

Examples of each of the 4 groups of Greek compounds are listed.

Compounds of ὄψ = *ops*, sight.

1. αἰθοψ, οπος = *aethops, -opis*, fiery-looking.
2. χάροψ, οπος = *charops, -opis*, bright-eyed, masculine and feminine adjective.

Nouns with -ωψ = *ops* as suffix.

1. σκάλοψ, οπος = *scalops*, *opis*, the digger, the mole, masculine noun.
2. δρύοψ, οπος = *dryops*, *opis*, woodpecker, masculine noun.

Compounds of ὤψ = *ōps*, eye, face.

1. κύκλωψ, οπος = *cyclōps*, *ōpis*, circle eye, Cyclops, masculine noun.
2. τυφλώψ, ῶπος = *typhlōps*, *ōpis*, blind-faced, blind, masculine and feminine adjective.

Nouns with -ωψ = *ōps* as suffix.

1. αἰγίλωψ, ωπος = *aegilōps*, *ōpis*, wild oats, masculine noun.
2. ὕδρωψ, ωπος = *hydrōps*, *ōpis*, dropsy, masculine noun.

As previously noted, botanical generic names ending in *-ops* are not numerous. The Greek masculine noun αἰγίλωψ, ωπος becomes the generic name *Aegilops*, *opis*, which is treated as feminine (as in *Aegilops orata*). *Echinops*, *opis*, *(Phoma echinopis)* is masculine (as in *Echinops dahuricus*). Some other generic names are *Massariellops* (Fungi), *Camarops* (Fungi), *Echinops* (Sperm), *Chamaerops* (Sperm), *Boops* (Sperm), *Melanops* (Fungi) and *Stenops* (Fungi). Some specific epithets in the genitive have been noted, as *Phoma echinopis*, *Metasphaeria chamaeropis* and *Puccinia aegilopis*. A variant is found in *Eredo boopidicola* from *Boops* (Sperm) in which the combining form is apparently believed to be *-opid-*. A limited search in botanical literature has revealed but one family name derived from a generic name ending in *-ops*, namely *Balanopsidaceae*, from *Balanops* = acorn face. Apparently this is based upon the assumption of a combining form *balanopsid-* and not *balanop-*.

The situation in zoology seems quite inconsistent. In a majority of cases the classical stem is recognized as in *Prionopidae* from *Prionops*, *Oonopidae* from *Oonops*, *Cyclopidae* from *Cyclops*, *Cryptopidae* from *Cryptops*, *Typhlopidae* from *Typhlops*, *Brachyopidae* from *Brachyops*, *Leptotyphlopidae* from *Leptotyphlops*. However, there are some zoologists who regard *-ops-* as the combining form, whence *Avocettinopsidae* from *Avocettinops*, *Eryopsidae* from *Eryops*, *Ceratopsidae* from *Ceratops*, *Tramatopsidae* from *Tramatops*, and *Edopsidae* from *Edops*. It is apparent that in biology three genitives of *ops* have been recognized, the classic *opis*, and also *opsis* and *opidis*, the second in zoology and the last in botany. These give combining forms that would yield for family names in botany *-opaceae*, *-opsaceae* and

-opidaceae. In zoology the corresponding forms would be *-opidae*, *-opsidae* and *-opididae*. It would seem that there exists undesirable confusion.

Adjectives having *ops* as a final component.

The Greeks also occasionally used -ωψ = *-ōps* and -οψ = *-ops* as masculine or feminine, never neuter, adjectival endings, as in the following:

γλαυκώψ, ῶπος = *glaucōps*, *ōpis* = with gleaming eyes.
μονώψ, ώπος = *monōps*, *ōpis* = one-eyed.
εὐρόοψ, ωπος = *euryops*, *opis* = far-seeing.
στέροψ, οπος = *sterops*, *opis* = flashing.

Some Greek adjectives ending in *ops* have been used as generic names, as *Typhlops* in zoology.

Adjectives ending in *-ops* are sometimes used as specific epithets in biology, as witness the following: *Sphaeria aethiops*, *Dothidia melanops*.

Nouns having endings derived from *ops* or *opsis*

The stems -ωπ- = *-ōp-* from ὤψ = ōps, and -οπ- = *-op-* from ὄψ = *ops*, also appear in various Greek nouns.

Feminine nouns:

ὀξυωπία = *oxyōpia*, sharpsightedness.
κυκλωπία = *Cyclōpia*, The Tale of the Cyclops.
στεροπή = *sterōpē*, flash, gleam or sheen.
ἐσωπή = *esōpē*, appearance, look.

In a few Greek feminine nouns the stem *opid-* appears as in:

αἱμαλῶπις, ιδος = *haemalōpis*, *idis*, a clot of blood.
κυνῶπις, ιδος = *cynōpis*, *idis*, the shameless one.
κυανῶπις, ιδος = *cyanōpis*, *idis*, dark-eyed.

Neuter nouns:

πρόσωπον = *prosōpum*, face, visage, countenance.
κυκλῶπιον = *cyclōpium*, the white around the ball of the eye, also diminutive of *Cyclops*.
σκολόπιον = *scolopium*, diminutive of *scolops*.

Masculine nouns:

κυνώπης, ου = *cynōpēs*, *ae*, the dog eyed one.
κυανώπης, ου = *cyanōpēs*, *ae*, the dark eyed one.

Adjectives having endings derived from ὤψ = ōps, ὄψ = *ops* or ὄψις = *opsis*,

Among Greek adjectives containing the stem *-ops-* are several that are used with suitable endings for all three genders, such as:

προσόψιος, os, ον = *prosopsius, a, um*, full in view.
κατόψιος, os, ον = *catopsius, a, um*, in sight of, opposite.

There are also several Greek adjectives with these endings including the stem *-opi-*, as:

κυκλῶπιος, os, ον = *cyclōpius, a, um*, Cyclopian.
ἐνῶπιος, os, ον = *enōpius, a, um*, face to face.

There are numerous Greek adjectives with endings which include the combining form *-op-*, as:

μυωπός, ός, όν = *myōpus, a, um*, short sighted.
κυανωπός, ός, όν = *cyanōpus, a, um*, dark looking.
ἀμπλωπός, ός, όν = *amplōpus, a, um*, bedimmed, dark.
χρυσωπός, ός, όn = *chrysōpus, a, um*, with golden eyes, beaming like gold, gold-colored.

There is always danger of confusion of adjectives derived from *ops* and ending in *-opus* with adjectives ending in *-opus* but derived from ποῦς, ποδός = *pus, podis*, the foot. For example, the adjective *chrysopus* in its masculine form may mean golden eyed or golden footed.

Another group of Greek adjectives used in three genders having the stem *-op-* includes those ending in ης, ης, ες = *ēs, ēs, es*, as:

λιθῶπης, ης, ες = *lithōpēs, ēs, es*, looking like stone.
κοιλωπής, ής, ές = *coelōpēs, ēs, es*, hollow eyed.
ἀμβλωπής, ής, ές = *amblōpēs, ēs, es*, dim, bedimmed, dark.
ὀξυωπής, ής, ές = *oxyōpēs, ēs, es*, sharp-sighted.

There are also a few Greek adjectives, feminine only, which show the stem *-opid-*, as:
κυκλωπίς, ίδος = *cyclōpis, idis*, cyclopean.
βοῶπις, ιδος, = *boōpis, idis*, oxeyed.
χρυσῶπις, ιδος = *chrysōpis, idis*, with golden eyes.

Nouns or adjectives which are derived from words other than the Greek ὄψ or ὤψ or ὄψις, but which may be confused with them.

The Latins also had a word *ops* apparently quite unrelated to the Greek ὤψ = *ōps*. It may appear in biological literature through derivatives.

ops, opis = Feminine noun, power, might, plenty.
Ops, Opis = Feminine noun, Goddess of Plenty.
inops, opis = adjective of one ending, without resources, helpless, weak.

Two other Greek words may appear in compounds and may prove to be confusing.

ὄψιος, α, ον = *opsius, a, um* = adjective, late. The combining

form is *ops-* or *opsi-*. It is the first component of many compound Greek nouns, as in ὀψίγονος, ος, ον = *opsigonus, a, um*, late born.

ὄψον, ου = *opsum, i*. Greek neuter noun, cooked meat, seasoning, sauce, dainty fare, or fish (a dainty). *Opso-* constitutes the first component of several Greek words as in:
ὀψοποιός, όυ = *opsopoeus, i*, masculine noun, cook.
ὀψοπόνος, ος, ον = *opsoponus, a, um*, adjective, dressing of foods elaborately.
The stem also appears as the last element of some Greek compounds as in:
παροψίς, ίδος = *paropsis, idis*. Feminine noun, a dainty side dish.
πολυοψία = *polyopsia, ae*, Feminine noun, abundance of meats or fish.
πολυόψος, ος, ον = *polyopsus, a, um*, adjective, abounding in fish, luxurious.

Summary.

1. There is confusing lack of agreement throughout biology, including bacteriology and microbiology, as to the correct combining form of the Greek words or suffixes *opsis, ops*, and *ōps*. This confusion is manifest in different methods of formation (1) of specific epithets derived from generic names, (2) of names of higher taxa, (3) of adjectives ending in *-opsis* or *ops* or derivatives of these and (4) the differentiation of the above compounds from those derived from other words with similar spelling.

2. Nouns having *-opsis* as a final component classically have a combining form *-ops-*. When transliterated into Latin, such nouns end in *-opsis*, with genitive singular *-opsis*. The names of higher taxa would logically be made by adding the appropriate ending; for example, the name of a family of plants or bacteria would end in *-opsaceae*, and the name of a family in zoology would end in *-opsidae*.

Zoologists have in general followed the classic procedure. Botanists have in the minority of cases followed Latin precedent, but in a large proportion of cases they have assumed the combining form to be *-opsid-* and have formed the specific epithets in the genitive as *-opsidis* and the family names as *-opsidaceae*. The matter is particularly confusing in microbiology which deals with names not only of bacteria but of plants and animals as well.

3. Adjectives ending in *-opsis* in Greek are masculine and feminine, never neuter. Were any transliterated by the Latins? If so, what genders? In biology, however, adjectives ending in *-opsis* have been used as specific epithets with neuter nouns.

4. Nouns having *ops* or *ōps* as a final component classically transliterated have the genitive *-opis* or *-ōpis* and the combining form *-op-* or *-ōp-*. The names of higher taxa would logically be formed by adding the appropriate ending, for example, the name of a family of plants or bacteria would end in *-opaceae*, and the name of a family in zoology would end in *-opidae*.

A majority of biologists have followed the classic form but there are exceptions. Three genitives have been used, the classic *-opis*, but also *-opsis* and *-opidis*. These give the combining forms *-op-*, *-ops-* and *-opid-* which would yield family names (botany and bacteriology) ending in *-opaceae*, *-opsaceae* or *-opidaceae*, and in zoology *-opidae*, *-opsidae* or *-opididae*.

5. Greek adjectives in *-ops* or *-ōps* are masculine or feminine, never neuter. A few specific epithets ending in *-ops* are in use in biology. Perhaps they may be regarded as adjectives with a single ending.

In view of the present use of several combining forms and declensions of generic names and specific epithets ending in *-opsis*, *-ops* and *ōps* and the consequent confusion in the naming of microorganisms, consideration and discussion of the following alternative suggestions are invited by all interested. It may be emphasized that the problems herein discussed are typical of many that concern bacteriology, botany and zoology. Microbiologists are particularly concerned as they must use the names of microorganisms included among bacteria, fungi, algae, protozoa and viruses, and also the names of their animal and plant hosts. Some coordination and unity of action among the three groups of biologists would be helpful. How may it be implemented?

Proposals:-

A1. An effort should be made through appropriate channels to secure a uniform ruling in bacteriology, botany and zoology relative to the combining forms of names of genera and of specific epithets ending in *-opsis*, *-ops* and *-ōps*, and of the names of higher taxa derived from them.

A2. The appropriate or recommended combining forms of generic names governed by the International Bacteriological Code of Nomenclature ending in *-opsis* is *-ops-*, in *-ops* or *-ōps* is *-op-*. The appropriate genitive ending for *-opsis* is *-opsis*, for *-ops* and *-ōps* is *-opis*. Family names derived from generic names ending in *-opsis* should end in *-opsaceae*.

Specific epithets and genitives formed on the assumption of

other spellings of the combining forms are to be regarded as orthographic variants which may be corrected.

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(3). Clements, F. E. and C. L. Shear. The Genera of Fungi. New York. 1931.

(4). Smith, G. M. The Fresh-water Algae of the United States. Ed. 2. New York. 1950.

(5). Becker, E. F. and L. B. Kuhn. Genera of the Protozoa. Mimeographed. Unpaged. Ames, Iowa. U. S. A. 1939.

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INTERNATIONAL BULLETIN

DESIGNATION OF NOMENCLATURAL TYPES OF TAXONOMIC GROUPS

Proposal for the Emendation of the International Bacteriological Code of Nomenclature

Preliminary Statement

The International Committee on Bacteriological Nomenclature at its meeting in Rio de Janeiro in August, 1950, approved certain recommendations made by the Judicial Commission relative to amendment of the International Bacteriological Code of Nomenclature. Among these recommendations were those having to do with the fixing of nomenclatural types of various taxonomic groups (taxa). An amendment relating to the fixing of type species for genera proposed by Messrs. Robert S. Breed, E. G. D. Murray and A. Parker Hitchens was approved in principle. It was agreed that an *ad hoc* committee should be appointed to make recommendations for all taxonomic groups. The committee appointed consists of the three members of the Editorial Board, Dr. J. Ramsbottom (London) and Dr. A.R. Prevot (Paris). The committee was directed to prepare draft proposals for consideration by the Judicial Commission, and when approved by the latter, to make provision for submission to the members of the International Committee on Bacteriological Nomenclature for vote. The Plenary Session of the Fifth International Congress of the Association of Microbiologists at Rio de Janeiro, in 1950, conferred authority upon the International Committee to take final action. Some emphasis was laid in the discussions at Rio de Janeiro upon the desirability of developing proposals that would be in conformity with the rules of botanical and zoological nomenclature insofar as the nature of bacteriological nomenclature allows.

The *ad hoc* committee has under consideration the draft revisions outlined herein. This committee will welcome criticism and discussion of the proposals before they are submitted formally to the Judicial Commission for its consideration. When finally considered and approved by the Judicial Commission and after publication in the BULLETIN, they will be submitted by the Permanent Secretaries to the International Committee on Bacteriological Nomenclature for suitable action.

Draft proposals for the emendation of Principle 11, Rules 9 and 17 are herewith submitted.

Principle 11

Comment. In accordance with previous action (1) of the International Committee, the word "taxa" is to be inserted after

"taxonomic groups" in the first line of Principle 11. It is proposed that the last sentence of the first paragraph be revised and transferred to Rule 17 (q.v.). This sentence seems to be phrased as a rule and not as a principle.

It is proposed that the second paragraph be revised and transferred to Rule 9 (q.v.), as also the paragraph on "Examples."

Draft Revision of Principle 11. The application of the names of taxonomic groups (taxa) is determined by means of nomenclatural types. A nomenclatural type is that constituent element of a taxonomic group (taxon) to which the name of the group is permanently attached.

Note. The nomenclatural type is not necessarily the most typical or representative element of a group. It is merely that element with which the name of the group is permanently associated.

Rule 9.

General Comment. Rule 9 is the single rule found in Section 2: Designation of Nomenclatural Types. It is supplemented by four Recommendations and a Note.

The special committee was directed to prepare proposals for revision of Rule 9, to include therein the essentials of the statement approved in principle at Rio de Janeiro, and to make provision for the fixing of nomenclatural types for all recognized ranks of taxonomic groups (taxa).

The preliminary draft revision of Rule 9 herewith submitted may be outlined as follows:

Rule 9. On the designation or selection of nomenclatural types.
9A. Nomenclatural types for the several ranks of taxa. (Present Recommendation 9a in part).
9B. Selection or designation of nomenclatural types.
9B1. Nomenclatural types of species and subspecies. (Present Recommendation 9d).
9B2. Nomenclatural types of genera and subgenera. (Present Recommendations 9b and 9c).
9B3. Nomenclatural types of taxa higher than genus.

Under each of these several headings there will be given comments and discussion, followed by a draft proposal.

9A. Nomenclatural Types for the Several Ranks of Taxa.

Comment. It would seem desirable first to define what is meant by the nomenclatural type of each of the several ranks of taxonomic groups (taxa) recognized in bacteriology.

Draft revision of Rule 9A. For each taxonomic group there

shall be designated a nomenclatural type. The type of a class or a subclass is an order, that of an order or suborder is a family, that of a family, subfamily, tribe or subtribe is a genus, that of a genus or a subgenus is a species, that of a species or subspecies is an authentic culture, specimen, preparation, illustration, or description.

Draft Revision of Recommendation 9a. When publishing the name of a new taxonomic group (taxon), authors should indicate carefully the nomenclatural type of the taxon being named. This type determines the application of the name in the event of this taxonomic group being subsequently divided.

Selection of Nomenclatural Types.

9B1. Selection of Types of Species and Subspecies.

Comment. The selection and designation of nomenclatural types of the bacteria, as well as those of many other microorganisms, differ from type selection for higher plants and animals in that in most cases it is highly desirable that the type be maintained as living material. Such type cultures representative of species, subspecies, varieties, and even strains should be maintained alive so that comparisons may be made between new material and these type cultures not only for morphology but for their physiological, cultural and serologic resemblances and differences as well. As far as is practicable, such cultures should be maintained in the national and international type culture collections, perhaps with special emphasis upon those forms which have special scientific or economic importance, and including type cultures of all species that are types of genera and higher taxa. It is recognized that at the present stage of our knowledge of culture techniques this procedure is not possible for many species and strains of microorganisms. It is therefore necessary that type specimens, preparations, figures and descriptions be recognized as constituting type material. Inasmuch as type cultures have been internationally agreed upon but are available in very few cases, it is highly desirable that methods of securing authentic substitute type cultures be set up. These are becoming increasingly important in determining microbial relationships.

Draft Revision Recommendation 9b. The utmost importance should be given to the preservation of the original "type" material on which the descriptions of new species and subspecies are based. If the microorganism is one which may be maintained in pure culture, an authentic culture designated as

the type culture should be deposited with one or more of the national or international type culture collections. When no such authentic culture is available a substitute type culture may be designated by the Judicial Commission upon the recommendation of a committee of experts. Bearing in mind the morphological, biochemical, antigenic and virulence changes that may occur as the result of repeated subculture, every precaution should be taken to maintain such cultures with a minimum amount of change. It is likewise important that descriptions, illustrations and differentiations of new species and subspecies be as complete as possible.

9B2. Selection of Types of Genera and Subgenera.

Comment. The recommendations made by Drs. Breed, Murray and Hitchens as approved in principle at Rio de Janeiro have to do primarily with the selection of the type species for genera. It is believed that in the draft proposal the essentials of the recommendations have been preserved.

Three categories of cases arise in the selection of a type species for a genus. The author of the generic name may have designated as the type one of the species described by him in the original publication, one which is identifiable at the present. If the author did not designate a type species, this may be done by a later author who selects one of the species described in the first publication of the genus. However, particularly in bacteriology, there occur cases in which none of the species named in the original publication can be identified. In some cases it may be wise to reject the generic name and the species originally described. In other cases the generic name has continued in use for later described and identifiable species. Provision should be made for all such cases if confusion is to be decreased and bacteriological nomenclature stabilized.

Draft Revision Rule 9B2.

a. The nomenclatural type of a genus or subgenus is the species or one of the species included when the name of the genus or subgenus was originally validly published.

b. If the author in the original publication of a generic or subgeneric name definitely selected a type species, this species shall be accepted as the type regardless of other considerations. (Type selection by original designation). The meaning of the expression "selected a type species" is to be rigidly construed. Mention of a species as an illustration or example of a genus does not constitute selection of a type.

c. If the author of a generic or subgeneric name in his orig-

inal publication failed to designate a type species, the type may be selected by a subsequent author, and the author who first makes the choice must be followed unless it can be proved that his choice is not in accordance with the rules.

(1) If the genus when originally published included but one species, this species shall be the type (selection by monotypy).

(2) If the genus when originally published included more than one species, the type species selected shall be one of these. However, *species inquirendae*, species doubtfully referred to the genus, species mentioned as in any way exceptional, species which definitely disagree with the generic description (provided others agree), and species which possess characters stated in the generic description as rare or unusual are to be excluded from consideration in selecting the type.

(3) If none of the species named by an author in his original description and publication of a generic name can be recognized, that is, if no identifiable type species can be selected in accordance with the rules, the Judicial Commission may issue an Opinion declaring such generic name to be a *nomen rejiciendum* and without standing in nomenclature. However, if such generic name has come into use for identifiable species named subsequently, one of these later species may be selected by international agreement as the type, with the generic name ascribed to the author of the binomial designated as the type. Such selection of a type and recognition of the author of the generic name must be based upon an Opinion by the Judicial Commission, and if such Opinion is questioned, its validity shall be determined by action of the International Committee on Bacteriological Nomenclature.

(4) The publication of a new generic name as an avowed substitute for an earlier one does not change the type of the genus.

9B3. Selection of Types of Taxa Higher than Genus.

Comment. Under the proposed emendation of rules the names of taxonomic groups higher than genus fall into four groups:

(1) Names of taxa higher in rank than family.

(2) Names of families, subfamilies, tribes and subtribes derived from the names of the type genera.

(3) Names of families derived from the names of contained genera which are not the gener-

ic types of the families.

(4) Families whose names have been approved as exceptions to the rule that family names should be derived from the name of a contained genus.

The existence of so many categories makes formulation of simple rules for the designation of nomenclatural types for these higher taxa difficult. Possibly consideration might be given to the elimination of No. 3 above. The number of exceptions to be made under No. 4 will not be known until decisions have been reached by the International Committee, but the number should not be large.

Draft Revision Rule 9B3.

The nomenclatural type of a family, subfamily, tribe or subtribe, whose name has been formed in conformity with the Rules and Recommendations, is that genus from whose name the name of the higher taxon has been derived. The nomenclatural type genus of a family whose name is recognized as an exception (See Note Rule 3) may be fixed by the Judicial Commission, preferably at the same time that approval to the exception is made. The nomenclatural types of taxa of rank higher than family may be fixed at the time of their proposal by the author. If not so fixed they may be designated by the Judicial Commission.

Section 5. Changes in Names as a Result of Segregation or Union of Groups or Change in Rank of Groups.

Comment. It is suggested that the last sentence of the first paragraph of Principle 11 belongs more appropriately with Rule 17 as a directive as to what action shall be taken when the nomenclatural type of a taxon is to be excluded.

Draft Revision. Rule 17.

Add to the first paragraph of Rule 17 the following sentence: "The name of a taxonomic group must be changed if the nomenclatural type of the taxon is excluded."

AMENDMENT OF RULE 24 (4) RELATIVE TO THE LEGITIMACY OF NAMES OF TAXONOMIC GROUPS WHICH ARE HOMONYMS

Preliminary Statement

At the meetings of the Judicial Commission and the International Committee on Bacteriological Nomenclature at Rio de Janeiro in August 1950 there was agreement that Rule 24 of the International Code of Bacteriological Nomenclature in its Section (4) should be amended. The resumé (1) of the minutes states that the amendment should "correct an error that had been overlooked when the Code was approved at Copenhagen. In the fourth paragraph of Rule 24 the word 'genus' was incorrectly used for 'taxonomic group', and it was agreed that an appropriate correction should be made."

The Editorial Board suggests consideration of the problem posed, and submits several proposals for study. Criticism and discussion by those interested are invited. The final wording of the proposals will be formulated by the Judicial Commission for submission to the International Committee on Bacteriological Nomenclature.

Rule 24 reads as follows:-
"A name must be rejected if it is illegitimate, i.e., if it is contrary to a rule. The publication of an epithet in an illegitimate combination must not be taken into consideration for purposes of priority. A name of a taxonomic group is illegitimate in the following cases:-

There then follow eight categories of names which are to be regarded as illegitimate. The directive for amendment refers to the fourth of these, which states that the name of a taxonomic group is not legitimate:-
"(4). If it is a later homonym of a genus of bacteria, of a genus of protozoa, or of a genus of plants, that is, if it duplicates a name previously and validly published for a group of the same rank based on a different type. Even if the earlier homonym is illegitimate or is generally treated as a synonym on taxonomic grounds, the later homonym must be rejected. When an author simultaneously publishes the same name for more than one group, the first author who adopts one of them, or substitutes another name for one of them, must be followed."

Several suggestions relative to rephrasing of Rule 24 have been made to make it clear that it is concerned not only with genera that are homonyms, but with taxonomic groups (taxa) of all ranks. Two alternative proposals have been made.

A. Draft Proposal for Emendation of Rule 24.

Revise the first paragraph of Rule 24 Section (4) to read as follows:- "If it is a later homonym of the name of a taxonomic group (taxon) of bacteria, plants or protozoa; that is, if it duplicates a name previously and validly published for a taxon of the same rank based on a different type."

B. Draft Proposal for Emendation of Rule 24.

Revise the first paragraph of Rule 24 Section (4) to read as follows:- "If it is a later homonym of the name of a taxonomic group (taxon) in bacteriology, botany or protozoology, that is if it duplicates a name previously and validly published for a taxon of the same rank based on a different type."

Legitimacy of Specific Epithets.

A question has been raised as to the legitimacy of specific epithets which are later homonyms. It may be pointed out that a specific epithet is not a taxonomic group, and that legitimacy of specific epithets which are homonyms is not determined by Rule 24. Rule 6 provides that within a genus no two species names may bear the same specific epithet. Further, Rule 7 provides that neither within the same species nor within the same genus may two subspecies bear the same subspecific epithet. However, the legitimacy of a species name (consisting of generic name and specific epithet) is determined by Rule 24. It is suggested that consideration might be given to an emendation of the code which would fix more clearly the status of specific epithets which are homonyms.

Rule 25 states:-
"Specific epithets are illegitimate in the following special cases and must be rejected.
(1) When they are merely words not intended as names.
(2) When they are merely ordinal adjectives being used for enumeration.
(3) When they exactly repeat the generic name (tautonyms)."

Draft Proposal for Emendation of Rule 25.

Modify the wording of Rule 25 and add a new section as follows:-
A specific epithet is illegitimate in the following special cases and must be rejected:-
(1) When it is merely a word not intended as a name.
(2) When it is merely an ordinal adjective used for enumeration.
(3) When it exactly repeats the generic name (tautonym).
(4) When it is a later homonym within the same genus, that is when it duplicates a specific epithet previously and validly published in a species of the same genus based upon a differ-

ent type.

Reference

(1). Cowan, S. T. and R. S. Breed. Resumé of Nomenclature Committee and Judicial Commission Meetings at Rio de Janeiro. International Bull. of Bact. Nom. and Tax. 1:4-7. 1951.

BACTERIOLOGICAL NOMENCLATURE AND TAXONOMY

FIFTH INTERNATIONAL CONGRESS FOR MICROBIOLOGY

RIO de JANEIRO

17th-24th August, 1950

Permanent International Committee
on Bacteriological Nomenclature

Enterobacteriaceae Subcommittee

A meeting of the Enterobacteriaceae Subcommittee was held on Saturday, 19th August, at 3:00 p.m.

Present: Dr. F. Kauffmann (Chairman)
Dr. R. E. Buchanan (by invitation)
Dr. S. T. Cowan (representing Brigadier J. S. K. Boyd)
Dr. P. R. Edwards
Prof. E. Hormaeche
Prof. Gunnar Olin
Prof. G. S. Wilson (representing Dr. Joan Taylor)
Dr. R. St. John-Brooks (Secretary)

Meeting of Enterobacteriaceae Subcommittee
August 19th, 1950

Dr. Kauffman presided and opened the meeting with a short statement of appreciation of the work of the late Mr. P. Bruce White as those present stood in silence in memory of their former colleague.

It was announced that Dr. Edwards had consented to act as joint chairman of the Subcommittee.

A summary of the report was read and certain changes in the report were noted. These changes involved the labelling of the proposed paracolon groups as provisional groups and a statement that cultures formerly labelled *Shigella rabaulensis* and *Shigella rio* should be placed in *S. flexneri* 4 without indication as to subtype until such time as their position is fully established. It was stated by the chairman that of 15 members of the subcommittee, one expressed no opinion of the report. Eleven were in agreement. Dr. Rauss did not approve the classification of *S. flexneri* and Drs. Boyd and Taylor were opposed to separation of the *Escherichia* and *Klebsiella* groups and to the formation of an international Escherichia Center.

Dr. Wilson was asked to open the discussion on behalf of Dr. Taylor, whom he represented.

He emphasized the fact that the opinions of Drs. Taylor and Boyd were identical with those of the British Enterobacteriaceae Subcommittee. He stated further that there was very strong opposition in England to the establishment of the genera *Escherichia* and *Klebsiella*. It was felt there that these groups proposed by the Subcommittee should be retained in the genus *Bacterium*, presumably as *Bact. coli* and *Bact. aerogenes*, although this point was not clarified in the discussion.

A general discussion ensued which centered about the coliform organisms and the use of the terms *Escherichia*, *Klebsiella* and *Bacterium*. It was emphasized by various members of the Subcommittee that the purpose of the report was to establish serological groups and not to erect genera. Dr. Wilson thought that some of the group names were so widely accepted as genera that the general bacteriological public would feel that the Subcommittee intended all groups to be genera. It was chiefly for this reason that he objected to the *Escherichia* and *Klebsiella* groups. Dr. Buchanan expressed the view that the term group could be used without generic connotation. Dr. Cowan stated that he believed that coliform organisms pathogenic for plants should be included in the work and that one or more plant pathologists should be made members of the Subcommittee. Dr. Kauffmann agreed. Dr. St. John-Brooks spoke of unpublished work which he had done on *Aerobacter* and *Erwinia* strains, indicating their close relationship.

On the question of an international Escherichia Center Dr. Wilson expressed the view that it was permissible to establish Salmonella and Shigella centers since the groups were well understood. However, in his opinion, establishment of an Escherichia center was premature since the group was ill-defined, the term *Escherichia* was objectionable for the reasons cited above, and the serology of the group in question was not well understood. These statements precipitated another prolonged discussion. Later it was brought out that the British Subcommittee thought the presentation of a *Proteus* antigenic schema based only on *P. vulgaris* and *P. mirabilis* also was premature. Dr. Kauffmann spoke of the time and expense involved in the typing and shipment of cultures and in the preparation of serums. His institute proposed to carry on this work as well as the Salmonella Center, with the money originally granted by The World Health Organization for the International Salmonella Center. This money as yet has not been received.

It was then decided to present the report of the Subcommittee

to the Nomenclature Committee and to instruct their secretary to write The World Health Organization concerning the extension of the International Salmonella Center to an International Salmonella and Escherichia Center and the establishment of two Shigella Centers, (a) a British and Commonwealth Center at Oxford, England, and (b) an International Center at Atlanta, Georgia, U. S. A. The objections of two members to the extension of the Salmonella Center to a Salmonella and Escherichia Center were to be recorded.

Dr. Wilson inquired regarding the method of establishment of centers and Dr. Buchanan explained that such centers were approved by the Nomenclature Committee and that the secretary of the Committee would write The World Health Organization concerning them. Dr. St. John-Brooks stated that The World Health Organization was moving toward formal relationship with the International Association of Microbiologists and that such a relationship would strengthen the position of the latter organization. Dr. Wilson suggested that the recommendations of the Subcommittee be referred to the Nomenclature Committee for action and there was general agreement.

The meeting was adjourned.

Ralph St. John-Brooks, Secretary

INTERNATIONAL BULLETIN

SOME ASPECTS OF THE TAXONOMY OF THERMOPHILIC BACILLI

Helge H. G. Gyllenberg

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The first question arising in connection with thermophilic bacteria is: What bacteria fulfill the requirements usually given for thermophilic organisms. In the suborder *Eubacteriineae* there are in fact, apart from the thermophilic group of aerobic sporeformers, only a few species characterised by thermophilic behaviour: *Lactobacillus thermophilus*, *Clostridium thermosaccharolyticum*, and *C. nigrificans*. In addition to these species, bacteria with optima between 37 and 50°C have often been termed thermophiles. This is true especially in the field of dairy bacteriology. Of this at least one illustration exists in the current edition of Bergey's Manual, viz. *Streptococcus thermophilus* Orla-Jensen. It would seem more correct if organisms that grow readily above 50°C, but whose optima lie below this point, were termed *thermotolerant mesophiles*. This term was proposed by Schillinger in 1898 with this significance.

As regards *Lactobacillus thermophilus*, it can be said that this organism is closely related to the homologous group of other lactobacilli, with their distinct thermotolerant character. Hence it may be a question of interpretation as to whether it is correct to classify this organism also as having the same characteristics of thermal temperature relationship. As to the clostridia, it may be observed that, although anaerobic cellulose decomposition is well known, it has thus far been impossible adequately to characterize the organisms causing this fermentation. It seems probable, however, that our knowledge of this group will be broadened in the immediate future. In spite of the possibility of descriptions of new thermophilic *Clostridium* species, it seems improbable that the thermophilic clostridia will constitute a definitely delimited group in any respect.

It is from this point of view that thermophilic bacilli are of special interest. At first glance the opinion that these organisms constitute a physiologically unique group may seem well founded. It has been proposed by some earlier authors that these thermophilic bacteria should be placed in a special genus (e.g. *Thermobacillus* Feirer). Although such a grouping would facilitate their differentiation from the mesophilic species, it must be born in mind that the ability to

form endospores does not constitute the sole resemblance between mesophilic and thermophilic aerobic spore-formers. In fact there are a number of morphological and physiological characteristics in common and a comparison of the mesophilic and thermophilic bacilli reveal some interesting facts.

As a starting point for such comparisons it may be emphasized that thermotolerance is characteristic of a number of mesophilic bacilli. Further, an identical basis for preliminary differentiation among the several species may be employed, particularly location and form of spores, shape of sporangia, and diameter of rods. The present author has attempted to determine the identity of certain thermophilic *Bacillus* strains by employing the current key to this group of bacteria. This proved unsuccessful, apparently in part because of the very inadequate data recorded for some thermophilic species. Thereupon a key to the *mesophilic* species was employed both with these strains and with the thermophilic species described. By this technique the relationship of the strains studied to the thermopoilic species patterns could be established in most cases. This method of identification also gave an interesting picture of the relation between the described mesophilic and thermophilic species.

The author found that 4 strains isolated by him were closely related to *Bacillus subtilis*. These strains could be characterized as thermotolerant, even though 2 of them grew at 65°C, but quite poorly. The remainder which did not grow at 65°C grew well at 57°C. One strain of each group failed to grow at 18°C. It seems that all of these strains were identical with *B. subtilis*, although they possessed an exceptional heat tolerance. On the other hand, these strains also seemed to be related to *B. thermodiastaticus*, differing most distinctly in their ability to grow at low temperatures. Variants of this type, capable of growth at 40° C, are, however, known (*Thermobacillus reductans* Feirer). Therefore it may be postulated that thermophilic, including stenothermal, variants of *B. subtilis* may exist.

On the basis of temperature relationships *B. kaustophilus* and *B. thermoindifferens* are more closely related to *B. subtilis* than is *B. thermodiastaticus*. They differ, however, from *B. subtilis* in certain physiological properties.

These species seem to be related also to *B. firmus* and *B. lentus* in some respects. A strain resembling *B. thermoindifferens*, studied by the author, was in fact sensitive to acidity in the medium.

As to the second group of thermophiles (*B. cylindricus*, *B. robustus*, and *B. calidolactis*) no distinct points of connection seem to exist with the corresponding group of mesophiles (*B. megaterium*, *B. cereus*). Among the strains studied by the author there were, however, 3 strains closely resembling *B. cereus* morphologically as well as physiologically. One of these 3 strains grew at temperatures from 18 to 57°C. The other two failed to grow at 28°, but grew well at 65°C. One of these, however, was incapable of hydrolysing starch.

The most noteworthy characteristic of the organisms of the first subgroup of mesophilic bacilli with distinctly swollen sporangia is the gaseous fermentation of carbohydrates (*B. polymyxa*, *B. macerans*). One thermophilic species able to produce gas from carbohydrates is known, but this (*B. thermoamylolyticus*) differs distinctly in its morphology from the gas-forming mesophiles.

The next group of mesophiles (sporangia swollen, no gas from carbohydrates, growing on ordinary media) includes the species *B. circulans*, *B. alvei*, *B. laterosporus* and *B. brevis*. To these correspond morphologically the thermophilic species *B. michaelisii*, *B. thermotranslucens*, *B. thermocellulolyticus*, *B. thermoalimentophilus*, *B. thermoliquefaciens* and *B. tostus*. Apart from the properties mentioned, it is very difficult to draw further conclusions concerning the relations of the species, due to the scanty data on the physiological properties of the thermophilic species. The author, however, has studied an organism which was related in most respects to *B. circulans*. This strain grew in the 39 to 65°C range, with a distinct optimum above 50°. Also *B. thermotranslucens*, and more distinctly *Thermobacillus linearius* Feirer, can be considered as related to *B. circulans*, but it is said that these fail to liquefy gelatin or reduce nitrates. Between *B. laterosporus* and *B. thermoalimentophilus* there seems to be some resemblance. Also *B. thermoliquefaciens* may be related to *B. laterosporus*. Four of the author's strains seemed to be related to *B. laterosporus*. All of these grew poorly at 65°, two grew at 28°, but none of them at 18°C. Three strains differed in that they lacked the ability to liquefy gelatin, and one of these in addition failed to reduce nitrates. Two of the author's strains were related to *B. brevis*. Both of these grew throughout the 18 to 65°C range. Some strains described by other authors can also be considered as related to *B. brevis*. This seems likely of *Bacillus nondiastaticus* Bergey, *Thermobacillus vulgaris* Feirer, and *Thermobacillus violaceus* Feirer. Feirer's strains, however, as stated in

descriptions fail to reduce nitrates or to liquefy gelatin.

On the basis of the comparison, outlined above it can be stated that the relationship between mesophilic and thermophilic bacilli may be closer than has commonly been considered. This aspect of the taxonomic position of the thermophiles has perhaps been by-passed since the temperature relations have appeared as more characteristic features than the other physiological properties. A noticeable question, and an object for further investigation may be, however, to establish how close are the relations in fact between both these groups of bacilli. It does not seem impossible that some of the thermophilic bacilli, when further investigated, may well be found to be included with known mesophilic species. If this were to be proved, the question of revising the current sub-grouping of the genus *Bacillus* (into mesophiles and thermophiles) will be opportune. The most important subject of investigation, however, is to broaden our knowledge of the physiological properties of known thermophilic species in order to diagram their mutual relationships, and to facilitate their determination.

NEWS AND NOTES

Membership of the Enterobacteriaceae Subcommittee. Revision of Membership List.

Dr. F. Kauffmann (Statens Seruminstitut, Amager Blvd., Copenhagen, Denmark), and Dr. P. R. Edwards (Enteric Laboratory, Chamblee, Georgia), Co-Chairmen, Dr. R. St. John-Brooks (Trinity College, Dublin, Ireland), Secretary.

Lt. Col. H. J. Bensted (London, England), Brigadier J. S. K. Boyd (London, England), Dr. D. W. Bruner (Ithaca, New York), Major P. R. Carlquist (New Haven, Connecticut), Dr. S. T. Cowan (London, England), Dr. W. H. Ewing (Chamblee, Georgia), Dr. W. W. Ferguson (Lansing, Michigan), Prof. A. Giovanardi (Milano, Italy), Dr. E. Hormaeche (Montevideo, Uruguay), Prof. Gunnar Olin (Stockholm, Sweden), Prof. K. Rauss (Pecs, Hungary), Prof. C. A. Stuart (Providence, Rhode Island), Dr. Jean Taylor (London, England).

It is with profound regret that we note the death of Lt. Col. R. F. Bridges of this Subcommittee. Lt. Col. H. J. Bensted (London, England), has been appointed to the Subcommittee in his place.

Streptococcus and Pneumococcus Subcommittee

The name of Dr. F. Kauffmann (Copenhagen, Denmark), was inadvertently omitted from the list of members of the Streptococcus and Pneumococcus Subcommittee.

Corrected and Completed Addresses.

The addresses of members of the International Committee on Bacteriological Nomenclature and its various subcommittees should be corrected or completed as follows:-

Dr. Gordon Davis, Hamilton, Montana, U. S. A. Leptospira Subcommittee.

Prof. Hugo Vaccaro, Instituto de Microbiologia e Immunologia, Casilla 370, Santiago, Chile. International Committee on Bacteriological Nomenclature.

Dr. Ruiz Falco, Instituto Nacional de Hygiene, Madrid, Spain. International Committee on Bacteriological Nomenclature.

Prof. F. Szymanoski, Dept. of Bacteriology, University, Lodz, Poland. International Committee on Bacteriological Nomenclature.

Addresses Requested.

Letters addressed to Prof. Dr. C. Ionescu-Mihaiesti, Faculty of Medicine, Sapiul Dr. Carol Davilla 6, Bucharest VI, Rumania, and to Prof. Dr. G. Zotta,

Sapiul Dr. Carol Davilla 6, Bucharest VI, have been returned Marked "not at this address." Corrected addresses will be appreciated.

Opinions Requested from the Judicial Commission.

Since the publication of the "List of Official Opinions of the Judicial Commission and of Requests for Opinion" Int. Bul. Bact. Nom. and Tax. 1:21-26, 1951, the following additional Opinions have been requested:-

File No. 48. Correct spelling of *Corynobacterium*.

File No. 49. Status of the generic name *Listeria* in bacteriology.

File No. 50. Spelling and status of the generic name *Gallionella*.

Errata

Please note the following errata in Vol. I No. II. (This Bulletin).

The pages of this issue should have carried volume page numbers 49-96 inclusive instead of issue page numbers 1-48.

p. 42 (Vol. Page No. 90) Column 1. Par. 2. Read *Bacillus hofmannii* for *Bacillius hoffmannii*.

p. 42 (Vol. Page No. 90) Column 2. Par. 2. Read *Borrelina* and *Borrellina* for *Borrelia* and *Borrellia*.

p. 44 (Vol. Page No. 92) Column 2, Par. 2. Read *vannielii* for *vannielli*.

p. 50 (Vol. Page No. 93) Column 1, Par. 1. Read Kauffmann for Kauffman.

p. 46 (Vol. Page No. 94) Column 1. Read *hofmannii* for *hofmanni*, and *imetrofa* for *imetropha*.

p. 47 (Vol. Page No. 95) Read Kauffmann for Kauffman.

Publication Dates of Microbiological Journals

The following letter from Dr. S. T. Cowan, Permanent Secretary of the International Committee on Bacteriological Nomenclature to the editor of the Journal of the Royal Naval Medical Service outlines a problem which not infrequently rises to vex one who is interested in determining the correct name of an organism on the basis of priority. It is essential that there be effective cooperation on the part of editors of journals in making readily available dates of publication to implement Rule 12 and accompanying Recommendations 12a, 12b, and 12c of the International Bacteriological Code of Nomenclature. Dr. Cowan writes:-

"I have recently had a problem presented to me that can only be resolved by finding out the

exact day of the month on which a journal and a book were published, and I am writing to you as editor of the Journal of the Royal Naval Medical Service to seek your co-operation in an attempt to avoid a repetition of this incident.

My problem concerns the validity of the names *Salmonella wien* and *Salmonella montreal* which have been applied to the same bacterium. *Salmonella wien* was described and named in a paper read before an Austrian Society in September 1950, but the proceedings of that meeting have not yet been published. Kauffmann used *S. wien* in his book "Enterobacteriaceae" published in March, 1951. In the March issue of the Canadian Journal of Public Health appeared a paper describing the same organism as *Sal. montreal*. By the rules of the International Bacteriological Code the valid name is the earliest binomial published in a journal or a book; earlier mention in a paper read at a meeting or the date of receipt of a Ms. by a journal have no standing. To solve my problem I have had to write to the editor of the Canadian Journal of Public Health and to the publishers of Kauffmann's book to ask the exact date of publication of each.

Problems such as this are few, but they would be avoided if the exact date of publication appeared in each issue of all journals. I realize that publishers cannot adequately forecast the exact date of publication, but the date of issue of the previous number is known and could be inserted in a part of the next issue that will be preserved when the cover and advertisements are removed for binding.

The Journal of General Microbiology has recently started to print on the first page of each issue the date of publication of the previous issue; for example on p. 1 of Vol. 5, No. 1 appears:
"No. 3, Volume 4 of the Journal of General Microbiology was issued on 10 October, 1950".

My request is that you would consider the insertion of the exact publication dates in your journal. I am making similar requests to editors of other journals."

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